STUDY PROJECT

OPERATING AND SUPPORT COST CONSIDERATIONS IN MAJOR WEAPON SYSTEM ACQUISITIONS

BY

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9 MARCH 1990

U.S. ARMY WAR COLLEGE, CARLISLE BARRACKS, PA 17013-5050

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In FY 90, Operating and Support costs accounted for 73% of the Army's budget request. Thus, in an era of decreasing budgets, it is not surprising that the O&S accounts are coming under increased scrutiny. The Army must be ready to evaluate options for reducing O&S costs while still maintaining its overall force readiness. Additionally, new systems in development must be carefully analyzed to ensure that support systems are being designed to operate within future O&S appropriations. The focus of this research paper was to

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take an objective look at O&S cost analysis in the Army. It examines the linkage between O&S cost analysis and the Army's Planning Programming, Budget and Execution System (PPBES). Additionally, the O&S costs of 25 weapon systems are evaluated in an effort to identify those areas where the Army should focus its O&S cost analysis. From here, the study then evaluates some of the analytical tools that can be used in this process, along with their attendant strengths and weaknesses. In summary, this study provides the background, analysis and evaluation of many of the critical issues surrounding O&S cost analysis in the Army. The study concludes with a set of recommendations which are directed at providing a logical framework for considering O&S cost analysis within the Army acquisition process.

USAWC MILITARY STUDIES PROGRAM PAPER

OPERATING AND SUPPORT COST CONSIDERATIONS IN MAJOR WEAPON SYSTEM ACQUISITIONS

AN INDIVIDUAL STUDY PROJECT

by

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ABSTRACT

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IN MAJOR WEAPON SYSTEM ACQUISITIONS

CHAPTER I

INTRODUCTION

Operating and Support (O&S) cost considerations in acquiring major weapon systems have received much attention in recent years. This can probably be attributed to the fact that a significant portion of dollars spent in the Defense Department fall in this category. Consequently, as budget cuts become more of a reality, this category of expenditures cannot help but become the object of intense review and debate.

Unfortunately, O&S costs are not well understood in the Army. The methods used to estimate these costs at the weapon system level of detail frequently bear no resemblance to the approach used to justify and receive funds through the Army's Planning, Programming, Budget and Execution System (PPBES). Additionally, data bases don't exist where actual expenditures can be compared to the original O&S cost estimates. Consequently, it is very difficult to update initial input parameters and improve basic cost estimating methodologies.

The objective of this research paper will be to identify what approach the Army should take with respect to estimating operating and support costs for both new and fielded systems. Since this process is inextricably linked to the PPBES process, both cost estimation and programming and budgeting will be fully discussed. Also, because the Army acquires and utilizes a large variety of weapon systems, a section of the report will be dedicated to reviewing O&S costs across a variety of weapon systems. The underlying question to be addressed is whether there are differences that exist which would support developing a unique cost estimating methodology for each commodity group. The final sections of the report will explore O&S costing in some detail within the Army. First, two O&S cost models will be examined. Both models are currently used within the Army Materiel Command. My review will present a short overview of each model and then an assessment of each of their strengths and weaknesses. The final chapter of the paper presents my analysis of what I consider the most critical factors impacting O&S cost analysis in the Army.

Chapters 1 through 6 will then provide the background, analysis and evaluation of many of the critical issues surrounding O&S cost analysis in the Army. Chapter 7 will summarize the conclusions of my research along with the recommendations which I feel provide a logical framework for considering O&S cost analysis within the Army acquisition process.

BACKGROUND

Overview of Operating and Support Costs

Life cycle operating and support cost is defined as "the sum of all costs resulting from the operation, maintenance and support (including personnel support) of the weapon system after it is accepted into the Army inventory. O&S cost buildup begins when the first production equipment enters the active or reserve force structure either as operating unit equipment or combat crew training equipment."[1]

Because life cycle O&S costs not only include the operation and support of equipment but also all personnel associated with the equipment, it is not surprising that it represents a sizable portion of the defense budget. As illustrated in Table 1.1, the Military Personnel and Operations and Maintenance accounts represent well over 56 per cent of the FY89 Defense budget, as well as over 55 per cent of the budget requests for both FY 90 and 91.[2]

However, when we analyze the Army's budget, we even find a significantly higher proportion of funds being spent in the O&S categories. As seen in Table 1.2, the Army's funding profile for FY 90 reveals that 73 percent of the budget will fall in the O&MA and Military Personnel accounts![3] The variance between the total Defense O&S outlays and those of the Army are caused primarily by the large quantities of manpower found in the Army as opposed to the lower manpower authorizations in the other Services. As of 31 March 1989, there was a total of 2.12 million personnel on active duty in all Services. Additionally, there were 1.66 million personnel in the National Guard and Reserve and 1.15 million civilian employees. The Army accounted for 36 per cent of the active duty strength of all Services and <u>64 per cent</u> of the national guard and reserve forces. Army civilian personnel accounted for 37 per cent of the Defense total.[4]

TABLE 1.1 FY 1990/91 DOD BUDGET ($B)

Category	FY89	%	FY90	%	FY91	%
Military Personnel	78.6	27.1	79.8	26.1	82.1	25.6
Operations & Maintenance	85.9	29.6	91.7	30.0	95.5	29.8
Procurement	79.2	27.3	84.1	27.5	91.9	28.6
Research, Dev., Test & Evaluation	37.5	12.9	41.0	13.4	41.3	12.9
Military Construction	5.7	2.0	5.3	1.8	5.9	1.8
Family Housing	3.3	1.1	3.3	1.1	3.7	1.1
Other	0	0	0.3	0.1	0.5	0.2
	$290.2		$305.6		$320.9	

Source: Your Defense Budget, The FY 1990/FY 1991 Biennial Budget[2]

TABLE 1.2 ARMY FUNDING PROFILE (TOA IN $B)

Operation and Maintenance		$27.8	(35%)
Active Component	$23.7		
Reserve Component	2.7		
Family Housing	1.4		
Military Personnel		$30.2	(38%)
Active Component	$24.7		
Reserve Component	5.5		
Investment		$21.0	(27%)
Procurement	$14.2		
RDTE	5.7		
Family Housing	0.1		
MILCON	0.9		
Stock Fund	0.1		
TOTAL	$79.0		

Source: The Army Budget, Amended Fiscal Year 1990-91[3]

In light of the fact that the Army's portion of the Defense budget is smaller than that of the Air Force and Navy (26% of the Defense budget goes to the Army as opposed to 33% for each of the other two Services),[5] these larger expenditures in the manpower accounts drive up the Army's proportion of O&S expenditures. Additionally, the Air Force and Navy tend to be much more equipment intensive. This then results in higher percentages of funds being spent in the Defense investment accounts and thereby lessening the overall impact of the higher O&S expenditures in the Army.

Army Operating and Support Expenditures

With over 73 per cent of the FY 90 budget representing O&S expenses, it's important that the categories of these expenses be fully understood. Consequently, this section will focus on the $23.7 billion in the Active Component Operation and Maintenance FY 90 budget and the $24.7 billion in military pay and allowances.

Table 1.3 provides a break out of the military pay account.[6] As one might expect, over 90 per cent of the dollars are for direct pay to the officer and enlisted personnel. Approximately 9.2 per cent of this total will be used for subsistence payments and PCS travel. As mentioned earlier, military personnel accounts for a large portion (38%) of the Army's budget and a very significant part (over 52%) of Army O&S costs.

The Operations and Maintenance account covers a much wider variety of expenses. Thirteen program elements comprise the

TAPLE 1.3 FY 90 MILITARY PAY ($M)

Category	$Million	%
Pay, Officer	6,279	25.4
Pay, Enlisted	15,975	64.7
Pay, Cadets	36	0.1
Subsistence	1,172	4.7
PCS Travel	1,123	4.5
Other	120	0.5
	$24,702	100.0%

Source: The Army Budget, Amended Fiscal Year 1990-91[6]

items in the OMA budget and are displayed in Table 1.4.[7] In order to more fully understand the major expenses in these elements, Tables 1.5-1.7 provide a break out for Base Operations (Program 12), General Purpose Forces (Program 2) and Central Supply (Program 7S).[8]

In addition to evaluating OMA expenses by program element, it is also useful to view this budget category by the type of expense incurred. In Table 1.8, it is again demonstrated that a sizable portion (27%) of the OMA account will be spent on personnel compensation and benefits. Additionally, contract expenditures of $11.6 billion (49%) will include a substantial amount of payments for personnel. The remaining expenses are then for services (transportation, utilities, etc.), rent, supplies, and travel.[9]

ENDNOTES

1. U.S. Department of the Army, DA Pamphlet 11-4, pp. 2-1 to 2-2. (Hereafter referred to as "DA PAM 11-4").

2. Department of Defense, Your Defense Budget, The FY 1990/FY 1991 Biennial Budget, p. 13.

3. Assistant Secretary of the Army for Financial Management, The Army Budget, Amended Fiscal Year 1990-91, p. 7.

4. "People," Defense 89 Almanac, September/October 1989, p. 25.

5. Your Defense Budget, The FY 1990/FY 1991 Biennial Budget, op cit, p. 13.

6. The Army Budget, Amended Fiscal Year 1990-91, op cit, p. 34.

7. Ibid., p. 35.

8. *Ibid*., p. 35-37.

9. *Ibid*., p. 35.

TABLE 1.4 OPERATION & MAINTENANCE, ARMY (OM&A) FY 90

Program	$Million
2 General Purpose Forces	4095
3I Intelligence	344
3C Communications	1132
7E Environment	0
7S Central Supply	3246
7M Maintenance	2550
8T Training	1201
8M Medical	2569
80 Other	774
95 Administration	1006
10 Other Nations Support	258
11 Special Operations	210
12 Base Operations	6324
TOTAL	$23709

Source: The Army Budget, Amended Fiscal Year 1990-91[7]

TABLE 1.5 FY90 BASE OPERATIONS

Category	$Million
Real Estate	247
Supply Operations	274
Maintenance of Materiel	205
Transportation Services	262
Laundry and Dry CLeaning	35
Army Food Service	286
Personnel Support	274
Housing	81
Utilities	720
Maintenance/Repair Property	1534
Minor Construction	170
Engineering Support	881
Administration	133
Automation	130
Reserve Component Support	6
Community and Morale Support	293
Preservation of Order	188
Directorate of Resource Mgmt	290
Directorate of Plans, Trng & Mob	126
Directorate of Contracting	64
Security and Counterintelligence	9
Records Mgmt and Publications	115
TOTAL	$6324

Source: The Army Budget, Amended Fiscal Year 1990-91[8]

TABLE 1.6 FY 90 P2 GENERAL PURPOSE FORCES

Category	$Million
Unit Training	1935
POMCUS	145
Other	232
Combat Development	229
JCS	95
Maintenance/Logistics	725
Information Mgmt	196
Combat Training Centers	137
Price Growth	111
TOTAL	$4095

Source: The Army Budget, Amended Fiscal Year 1990-91[8]

TABLE 1.7 FY 90 CENTRAL SUPPLY - PROGRAM 7S

Category	$Million
Supply Activity	1273.2
Industrial Operations	114.2
Transportation & Port Operations	834.7
Logistics support	645.1
Commissaries	279.0
TOTAL	$3146.2*

* Total program is $3245.5 which includes $99.3M which passes to the AIF.

Source: The Army Budget, Amended Fiscal Year 1990-91[8]

TABLE 1.8 FY 90 OM&A BY TYPE OF EXPENSE

Category	$Million
Personnel Compensation & Benefits	6381
Transportation	888
Supplies, POL, Equipment	3002
Communications, Utilities, Rent	1164
Contracts	11586
Travel	688
TOTAL	$23709

Source: The Army Budget, Amended Fiscal Year 1990-91[9]

CHAPTER II

COST ANALYSIS IN THE ARMY

This chapter will present the Army's cost analysis program from several perspectives. The first part of the chapter deals with the various analyses/estimates which are found during the life cycle of Army materiel: the Baseline Cost Estimate (BCE), the Independent Parametric Cost Estimate (IPCE) and the Cost and Operational Effectiveness Analysis (COEA). The final part of this chapter then deals with how the Army structures its life cycle cost estimates, with particular emphasis on how each of the elements of life cycle operating and support cost are considered.

ARMY FORMATS FOR COST ANALYSIS AND ESTIMATION

The Baseline Cost Estimate (BCE)

The Army cost analysis program is designed to provide information to Army decision makers throughout the materiel acquisition process. One of the basic instruments used in this process is the Baseline Cost Estimate (BCE). The BCE is "a generic term denoting a complete, detailed and fully documented estimate of materiel system life cycle costs accomplished by the system proponent (weapon system project manager). It is a dynamic document appropriately refined and updated throughout the acquisition cycle. It serves, after review and validation, as the principal cost estimate for that system. ... The BCE becomes the basis for projecting funding requirements for acquisition and operation of the materiel system."[10]

Early BCEs generally use a variety of parametric techniques to estimate system costs. As the system specification matures and data availability improves, the BCEs use more detailed engineering cost estimates. As a minimum, AR 11-18 requires that BCEs be updated for each major decision point in the materiel acquisition cycle.

Independent Parametric Cost Estimates (IPCE)

The IPCE is performed primarily for the purpose of testing the reasonableness of the estimates contained in a BCE. The IPCE is accomplished outside the materiel development community and is a much more highly aggregated cost analysis. As its name implies, it will generally use parametric techniques as a basis for exploring and challenging the costs and assumptions contained in the BCE. Factors which are frequently considered include development time, testing requirements, quantities, inflation assumptions and fielding/deployment schedules. The HQDA Comptroller (COA) is responsible for developing IPCEs for selected materiel systems.[11]

As with the BCE, the IPCE must cover the total cost of ownership and thus includes funds to develop, acquire, operate and support the system. Experience in similar systems is used to the maximum extent possible. Statistical techniques are used to develop cost estimating relationships (CERs) to support the final analysis. Additionally, other nonparametric techniques are employed such as analogy with like systems and even expert opinion when data are not available to support quantitative analysis.

The IPCE and other independent estimates provide an unbiased look at the costs presented in the BCE. As such, it serves an important purpose in providing the Army's leadership with additional review and analysis of critical system costs at key decision points of the acquisition process.

Cost and Operational Effectiveness Analysis (COEA)

The Cost and Operational Effectiveness Analysis (COEA) is a study generally conducted by TRADOC which is intended to evaluate and rank alternative "systems" based on their overall cost and operational effectiveness. The use of the word "system" in this context can mean one or multiple weapon systems. Consequently, the focus of the COEA is all materiel required to meet a particular requirement. COEAs are conducted throughout the materiel acquisition process to ensure that the candidate system is cost and operationally effective. For major systems, the analysis will generally include a base case, a proposed system and its alternatives which are all employed in a standard scenario. The force in the base case is then modified to accommodate the changes proposed in each alternative and cost estimates are prepared to identify and analyze the changes. While COEAs may use the BCE and IPCE of the individual systems being considered, they frequently concentrate on the high cost drivers and don't necessarily focus on total life cycle costs.[12]

LIFE CYCLE COSTING

Prior to 1983, the Army classified life cycle costs in three categories: Research and Development, Investment, and Operating and Support. However, a HQDA tasker dated 10 June 1983 (DACS-DPZ-B) directed that the cost analysis community expand the number of cost categories. Commonly referred to as the "Big Five" categories, they include the following: Development, Production, Military Construction, Fielding and Sustainment.[13]

The primary purpose of this change was to better integrate the weapon system cost methodologies with the Army's PPBES system. While DA PAM 11-4 has remained unchanged, the DCA PAM 92 constitutes the primary guidance for preparing O&S cost estimates. Thus, an understanding of each of the basic cost elements is necessary to fully understand the scope of O&S costing.

As noted in Table 2.1, the costs for R&D, Procurement and Military Construction are fairly straightforward and directly parallel their budget appropriation. However, the Fielding and Sustainment categories are not as straightforward. The fielding costs cover those associated with passing ownership from the manufacturer to the government. The range of fielding costs can be quite broad if the system is being distributed across the entire Army or conversely, quite small, if it is a low density item

TABLE 2.1 COST ELEMENTS FOR DEVELOPMENT, PRODUCTION AND MILITARY CONSTRUCTION

Cost Element	"Big 5" Ref. No.	Appropriation
Development	1.0	R&D
Dev. Engineering	1.01	R&D
Engineering	1.011	R&D
Prod., Eng., & Plan (PEP)	1.012	R&D
Tooling	1.013	R&D
Prototype MFG	1.014	R&D
Data	1.02	R&D
System Test & Evaluation	1.03	R&D
System/Project Mgmt	1.04	R&D
Train Service & Equip	1.05	R&D
Facilities	1.06	R&D
Other RDTE	1.07	R&D
Production	2.0	Proc
Non-Recurring Prod.	2.01	Proc
Int. Prod. Fac.	2.011	Proc
Prod. Base Support	2.012	Proc
Depot Maint. Plant Equip.	2.013	Proc
Other Non-Recurring Prod.	2.014	Proc
Recurring Production	2.02	Proc
Manufacturing	2.021	Proc
Recurring Engineering	2.022	Proc
Sustain tooling	2.023	Proc
Quality Control	2.024	Proc
Engineering Change	2.03	Proc
Data	2.04	Proc
System Test and Evaluation	2.05	Proc
Train Service and Equip	2.06	Proc
Initial Spares	2.07	Proc
Operational Site Activities	2.08	Proc
Other PA funded activities	2.09	Proc
Military Construction	3.0	MC
Test Construction	3.01	MC
Production Construction	3.02	MC
Operational Site Construction	3.03	MC
Other MCA Funded Construction	3.04	MC

going to only a few units. Because these are one-time costs, they are not treated as O&S costs, despite the fact that they are financed from the O&MA appropriation. (See Table 2.2)

The Sustainment category (5.0) is where one really appreciates the multitude of appropriations involved with operating and supporting the Army's equipment. Table 2.3 lists each of these elements and identifies the primary appropriation category. Note that all of the operating and support cost elements that were formerly defined in DA PAM 11-4 are now contained in Sustainment (5.0). However, two elements of Sustainment costs are not considered to be in the O&S category. These are military pay and operations and maintenance costs associated with project management personnel (5.085 and 5.09). Again, this is because they are viewed as one-time costs associated with developing the weapon system and not attributed to the system after it is fielded.

Because the focus of this paper is on operations and support costs, the next section will provide a detailed explanation of each of the elements of O&S cost.

ELEMENTS OF OPERATING AND SUPPORT COST[14]

Sustainment costs (5.0) capture those costs incurred from the time a system is fielded until it is retired from service. On a year-to-year basis, these costs can vary dramatically as the density of the system changes or as usage tempos change to support operational training missions. Eleven elements make up this

TABLE 2.2 COST ELEMENTS FOR THE FIELDING

Cost Element	"Big 5" Ref. No.	Appropriation
Fielding	4.0	O&MA
System Test & Evaluation	4.01	O&MA
Train, Service & Equip	4.02	O&MA
Transportation	4.03	O&MA
Initial Repair Parts	4.04	O&MA
System Spec., Base Opns.	4.05	O&MA
Other O&MA Funded Fielding	4.06	O&MA

TABLE 2.3 COST ELEMENTS FOR SUSTAINMENT

Cost Element	"Big 5" Ref. No.	Appropriation
Sustainment	5.0	-
Replenishment	5.01	-
Repl. Repair Parts	5.011	O&MA
Repl. Spares	5.012	Proc
War Reserve Repair Parts	5.013	O&MA
War Reserve Spares	5.014	Proc
POL	5.02	O&MA
Ammunition	5.03	Proc
Training Ammo	5.031	Proc
War Reserve Ammo	5.032	Proc
Depot Maintenance	5.04	-
Depot Maint. Civilian Labor	5.041	O&MA
Materiel (O&MA)	5.042	O&MA
Materiel (Proc)	5.043	Proc
Maint. Support Activities	5.044	O&MA
Field Maintenance Civilians	5.05	O&MA
Transportation	5.06	O&MA
System Spec. Repair Training	5.07	-
Ammo/Missiles	5.071	Proc
Services	5.072	O&MA
Military Pay & Allowances	5.08	MPA
Crew P&A	5.081	MPA
Maintenance P&A	5.082	MPA
System Specific P&A	5.083	MPA
Trainee/Trainer P&A	5.084	MPA
System Project P&A	5.085	MPA
PCS	5.086	MPA
Other MPA	5.087	MPA
System Project Mgmt Civilian	5.09	O&MA
Modification Kits	5.10	Proc
Other Sustainment	5.11	-
O&MA	5.111	O&MA
Proc	5.112	Proc

overall category which by-and-large captures the O&S costs attributable to any weapon system.

Replenishment Spares and Repair Parts (5.01)

This subcategory includes all spares (repairable components) and repair parts (nonrepairable parts) required to sustain the weapon systems during normal peacetime operations as well as establishing the levels required to meet war reserve stockage objectives.

Replenishment Repair Parts (5.011)

This element includes all O&MA costs for repair parts which are funded by stock fund and consumer appropriations. It does not include repair parts which are provided as initial stockage for the ASL/PLL and wholesale depot system (see element 4.04). These parts are nonrepairable assemblies and subassemblies used in repairing spares or the major system itself. O&MA funded depot parts are not included in this category.

Replenishment Spare Parts (5.012)

This cost element captures those procurement appropriated funds required for resupplying the initial stockage of spare (repairable) components. These items are commonly referred to as "washouts" because they are reparable items which can no longer be economically repaired. This element does not include any of the procurement funded spares required for depot maintenance (5.043) or the initial spares needed to fill the gaining unit's ASL/PLL.

War Reserve Repair Parts (5.013)

This element represents those O&MA funds required to purchase war reserve repair parts which have been found to be essential to operating the weapon system in a wartime environment. The quantities required are equivalent to that which is needed to establish the wartime pipeline until resupply can be established.

War Reserve Spares (5.014)

This element represents those procurement funds required to purchase war reserve spares which have been found to be essential to operating the weapon system in a wartime environment. The quantities required are equivalent to that which is needed to establish the wartime repair cycle quantity.

Petroleum, Oils and Lubricants (POL) (5.02)

This element includes all O&MA appropriated funds required to provide POL to support peacetime operations.

Ammunition and Missiles (5.03)

This element includes the procurement funded costs for all ammunition/missiles required for both training (5.031) and war reserves (5.032). The training costs include both unit training as well as annual service rounds. The war reserves include the unit basic load and also the sustainment ammunition specified by the Defense Guidance.

Depot Maintenance (5.04)

This element includes all labor, materiel and overhead required to accomplish depot-level maintenance and overhaul. O&MA funded civilian labor (5.041) includes both civilian service and contractor-performed depot maintenance. Materiel which is required to support the depot maintenance mission is separated into that which is O&MA funded (5.042) and that which is procurement funded (5.043). The final category of depot maintenance costs is that associated with O&MA funded depot maintenance support activities (5.044). This includes such things as field support, engineering services, technical assistance and updating publications.

Field Maintenance Civilian Labor (5.05)

This element includes the O&MA funded costs with all civilian maintenance labor used below depot level. Examples would include the installation of modification kits and all contractor-performed DS/GS level maintenance.

Transportation (5.06)

This element captures all transportation costs involved with moving the item to depot maintenance facilities or training facilities. It also includes the transportation costs of all associated secondary items (e.g., repair parts and ammunition) to forward stockage points.

System Specific Replacement Training (5.07)

Training Ammunition/Missiles (5.071)

This element includes all procurement funded support required to train replacement personnel. It includes the cost of all training ammo/missiles as well as any equipment consumed in this mission.

Training Services (5.072)

This element includes all O&MA funded support required to train replacement personnel. It includes the cost of courses taught in TRADOC schools as well as all recurring costs for training materiel and devices.

Military Pay and Allowances (MPA) (5.08)

Military pay and allowances accounts for a substantial portion of operating and support costs. The DCA PAM 92 identifies seven levels of military pay, as described below. In each category, pay allowances include all basic pay and allowances, as well as applicable theater and flight pay.

Crew MPA (5.081)

This element includes the MPA cost for all military personnel who have primary responsibility for operating the weapon system being costed. It does not include the MPA costs of personnel operating ancillary equipment (e.g., trucks and switchboards).

Maintenance MPA (5.082)

This element includes the MPA cost for all military maintenance personnel below depot level who have primary responsibility for maintaining the system being costed. It does not include the maintenance MPA associated with ancillary equipment (e.g., trucks and switchboards).

System Specific Support MPA (5.083)

This element includes all other MPA for military personnel below depot level who are required to support the weapon system but are not defined as crew or maintenance personnel. It includes such personnel as truck drivers and mechanics, company commander, fuel handlers and ammunition handlers.

Trainee/Trainer MPA (5.084)

This element includes all MPA associated with the replacement personnel being trained as well as the instructors who are providing the training. The training must relate to future assignments on the weapon system being costed.

System Project Management MPA (5.085)

This element captures the MPA of military personnel assigned to either the project manager's office or TRADOC System Manager (TSM). While it is not an element of Operating and Support, it is included under sustainment because it covers the life of the system.

Permanent Change of Station (PCS) (5.086)

This element includes the MPA costs associated with moving replacement personnel both within CONUS and to and from overseas areas where the system is deployed.

Other MPA Funded Sustainment (5.087)

This final category captures any other system-related MPA that were not found above.

System Project Management Civilians (5.09)

This element includes all O&MA funds required to man the civilian spaces in the system project management office for the life of the system. While this is not considered an O&S cost, it does appear in overall sustainment costs.

Modification Kits (5.10)

This element includes all procurement funds associated with modifications made to the weapon system after it is accepted by the Army. Labor costs are generally not included as they will be found in the appropriate maintenance category.

Other Sustainment (5.11)

This element captures all other system specific costs which are not included in any of the above categories. It is broken into O&MA funded (5.111) and procurement funded (5.112) expenses.

Exclusions from O&S Costs

There are also a number of areas that while on the surface appear to be appropriately categorized as O&S costs, they are in fact excluded from this category. Examples include:

o Costs that are incurred during research and development and acquisition phases. These are looked at as one-time costs and consequently are treated as investment costs.

o Training missiles and munitions that are acquired during the investment phase.

o Costs which are not directly related to the system and more correctly a cost of having a standing Army. Examples include costs of HQDA, ROTC, and reenlistment bonuses.

o Disposal costs -- those costs of removing an item from service are not considered an O&S cost.[15]

ENDNOTES

10. U.S. Department of the Army, Army Regulation 11-18, pp. 2-1 to 2-3. (Hereafter referred to as "AR 11-18").

11. Ibid., p. 2-3.

12. Ibid., p. 2-4.

13. Office of the Comptroller of the Army, DCA-P-92 (R), p. 2-11. (Hereafter referred to as "DCA PAM 92").

14. _Ibid_., pp. A-1 to A-17.

15. _Ibid_., p. 2-4.

CHAPTER III

THE ARMY BUDGET PROCESS

The Baseline Cost Estimate (BCE) is the procedure used by the PM to estimate his system's life cycle costs. The procedures are covered by DA PAM 11-4 and DCA PAM 92 which were discussed in the last chapter. The BCE is not the mechanism, however, by which the Army receives dollars to operate and support the weapon system after it is fielded. Operating and Support funding is achieved through the program analysis and resource review modernization resource information submission (PARR/MRIS) which is a subset of the planning, programming, budgeting and execution system (PPBES). There are many differences that exist between the development of O&S cost estimates in the BCE and funding O&S requirements in the PARR/MRIS system. As discussed in Chapter 2, the PM will generally use a mathematical cost estimating model to generate the life cycle costs for his system. Input to this model can often be based largely on engineering estimates, particularly if the system is early in its life cycle. The BCE considers the life of the system; thus, it will normally estimate costs for as much as 20 to 30 years. Output of the BCE is formatted in the "Big 5" categories of Development, Investment, Military Construction, Fielding and Sustainment. As we saw earlier, it was only with the revision of DA PAM 11-4 (in DCA PAM

92) that there was any relationship between the Big 5 categories and the appropriations from Congress which actually provide dollars to the Army.

Lets now review the budgeting process. The major appropriations categories used by the Congress to provide funds to the Services are:

- o Military Personnel *
- o Operations and Maintenance *
- o Procurement (Aircraft, Missiles, Weapons and Tracked Vehicles, Ammunition and Other)
- o Research, Development, Test and Evaluation (RDTE)
- o Military Construction
- o Family Housing
- o Army Stock Fund *

Those marked with an asterisk represent those appropriations which would contain O&S funds.

The Army's Planning, Programming, Budgeting and Execution System (PPBES) is the process by which the Army develops and maintains its portion of the Six Year Defense Program (SYDP) and the Defense Budget. The PPBES integrates the programs which are centrally managed (i.e., Military Manpower, RDTE, Procurement, ASF, Construction and Housing) with the operation and maintenance budgets developed by the Major Army Commands (MACOMs) and Army field operating agencies. O&M budgets are developed by the MACOMs in two ways. First, the Modernization Resource Information Submission (MRIS) is the process used by the MACOMs to estimate the O&S costs required to support the large influx of new systems involved in the modernization process. Because this number is quite large, only selected systems having the highest O&S costs are included. The Army Modernization Information Memorandum (AMIM) is published biennially and provides the basic input data required by the MACOMs to develop their individual budget submissions by weapon system. The remaining weapon systems are then managed at an aggregate level of detail with resource requirements being provided through Management Decision Packages (MDEPs). The MDEPs consist of two parts: Program Development Increment Packages (PDIP) and the Budget Increment Package (BIP). The PDIP covers the six program years in the Army's Program Objective Memorandum (POM). The BIP covers a three year period that includes the past year, current year and budget year. The MDEP can be the support required for a specific program or function (e.g., TOE unit, TDA mission, weapon system, garrison operation, etc.). As mentioned above, the Army MACOMs submit their POM and MRIS requirements to HQDA. MACOMs who support CINCs are required to incorporate the CINC's requirements in their POM submissions.[16]

MDEPs are then submitted to a prioritization process. During this process, some are protected, while others are resourced at risk or recognized as unresourced needs. The prioritization is accomplished within one of nine functional area panels: structuring, manning, training, mobilizing and deploying, providing facilities, managing information, equipping, sustaining and managing. Obviously, many of these areas include O&S costs. The results of this initial prioritization are then sequentially presented to the Program Budget Committee, the Prioritization Steering Group, and the Select Committee (SELCOM). Based on the recommendations of the SELCOM, the Secretary of the Army and Chief of Staff make the final decisions on what programs are resourced. This then locks the POM which is then translated into the budget process.

Each of the MACOMs then use their POMs to create their Command Operating Budget (COB). The COB identifies their requirements for the prior year, current year, as well as the upcoming fiscal year. It also includes additional workload and budget data which are required to evaluate the budget estimates. Each of the separate estimates are then reviewed and eventually amalgamated into a single budget for each appropriation. The budget estimates are then reviewed by the Program Budget Committee (same committee which reviewed POM), Assistant Secretary of the Army (Financial Management), the SELCOM and then finally to the CSA and SA for final decision. This then completes the formal process within the Army for budget submission. It will then be subjected to review by OSD, OMB, and then the Congress before funds are finally appropriated to the Army.[17]

As seen, there are some very fundamental differences between how O&S costs are estimated and how the Army programs and budgets for the operation and support of its weapon systems. In a recent article on Patriot O&S cost reductions, the authors report that many differences existed in Patriot between the BCE and MRIS:

> "Besides methodology differences, there are systemic differences. Some of the major differences for

Patriot are guidance, timing of guidance, procurement schedules, operating tempo, fuel consumption factors and validation process.

Different guidelines and their timing provided different assumptions for estimates. Procurement schedule differences would provide different deployment schedules. Although updated by the Army staff during the program objective memorandum building process, estimates were not recosted by the original estimating Major Command. This created a disjointed estimating process, especially affecting estimates of fielding cost and the quantity of units to be supported under the sustainment cost. Operating tempo differences especially impacted sustainment cost in the areas of petroleum, oil and lubricants and repair parts. Cost-factor differences affect all areas of fielding and sustainment. The different validation process created separate channels for test of reasonableness. All baseline cost estimates flow through one channel of validation, while modernization resource information system validation flows through Major Commands and Department of the Army appropriation/subappropriation directors."[18]

Certainly the methodology differences between MRIS and BCE preparation should be resolved. However, such improvements still will not clarify the relationships between cost estimating and budgeting. For the FY90 Army OM&A budget, it was estimated that only $1 billion of the $27.8 billion O&MA budget was derived from the MRIS procedures. Consequently, only a very small portion of the OM&A budget can be directly linked to specific weapon systems. The remaining portion of the O&MA budget was aggregated through the MDEP process.

Is it reasonable to assume that a relationship between weapon system cost estimates and Army budget can ever be forged? Probably not -- largely because of two major factors. First, not all systems have BCEs. While BCEs are required for all major systems, there still remains a significant number of smaller systems which do not require that BCEs be developed. Secondly, there's a significant portion of the Army's O&MA budget which is required to support many administrative functions. For example, one-third of the Army's force structure is applied to administrative areas (e.g., the TDA Army). While some of these costs can be related to weapon systems (e.g., those in RDTE), there still remains a significant number of dollars where the relationship of O&MA to specific weapon systems is very nebulous. Consequently, we can expect that the relationship between budget and cost estimation will continue to be very blurry. To ensure that the Army gets the most out of its O&MA dollars, it seems two approaches are required. First, O&MA support to TDA and other administrative functions require highly proficient organizational designs. On the other hand, at the weapon system level, the Army must evaluate systems early in their life cycle to ensure that both operational and support concepts are efficiently designed. I have directed this research paper toward this latter area. The remainder of this report will address basic methodologies, variances in O&S costs among the many commodities used in the Army and finally, other key factors which impact O&S cost analysis in the Army.

ENDNOTES

16. U.S. War College, Army Command and Management: Theory and Practice, pp. 14-9 to 14-18.

17. Ibid., pp. 14-21 to 14-25.

18. Patrick Renegar and Jessica D. Geary, "The Operating and Support Cost Reduction Program," January-February 1987, p. 40.

CHAPTER IV

O&S COST REVIEW BY COMMODITY AREA

A question which needs to be addressed is whether or not the Army would benefit from a standardized O&S cost model which could be used in assessing weapons across all commodity areas. Each AMC major subordinate command (MSC) has, for the most part, unique models which have been developed to evaluate O&S costs and design trade-off decisions. Two of these models will be discussed in the next chapter.

The feasibility of standardization will be influenced largely by the variation of each of the individual cost elements. If this variation is correlated to a commodity group, then it might be worthwhile to develop models which are specifically designed to estimate the cost drivers in each respective commodity area.

In March 1989, a joint AMC-TRADOC effort was initiated to address programs for reducing O&S costs in the Army.[19] My research in this area was aided immensely by this study group. One of their initial actions was to review the BCEs of 25 weapon systems and determine what elements were driving the O&S costs. First, Table 4.1 provides a summary of each system's life cycle costs.[20] As expected, a large percentage of their life cycle costs appear in the Sustainment category. Exceptions to this rule were found in a number types of munitions (Copperhead

TABLE 4.1 LIFE CYCLE COST DISTRIBUTIONS

System	Dev.	Percentage of LCC in: Prod.	MCA	Field	Sustain.
Air Defense					
LOS-F-H	2	42	-	1	55
LOS-R	-	22	-	1	77
NLOS	9	35	-	1	55
Patriot	12	33	1	1	53
Stinger	5	34	-	-	61
Armaments					
Copperhead	11	88	-	-	1
SADARM	17	82	-	-	1
Aviation					
AHIP	3	34	-	1	62
APACHE	6	33	-	1	60
Blackhawk	3	30	-	1	66
Chinook	2	28	-	3	67
LHX	6	48	-	1	45
Automotive					
FMTV	1	17	-	2	80
PLS	1	22	-	2	75
Commo/Electronics					
MSE	-	21	-	-	79
JSTARS	15	21	-	1	63
FAADC2I	17	23	-	2	58
SINCGARS	3	49	-	4	44
Satellite					
GPS	13	64	-	7	16
Fire Support					
AAWS-H	9	37	-	1	53
AAWS-M	8	41	-	1	50
HELLFIRE	17	64	-	-	19
MLRS	2	33	1	2	62
TACMS	47	39	-	1	13
TOW	2	18	-	-	80

and SADARM), missile systems (Hellfire and TACMS), and satellite systems (GPS). These systems have most of their life cycle costs tied up in R&D and acquisition and as such, would not benefit or need an O&S cost model for estimating purposes. The R&D dollars are sunk early in the program and investment costs are known when initial contracts are negotiated. Consequently, if we remove these from the sample, then the average sustainment costs for the remaining systems was found to be 62.3% of total life cycle costs. It is equally interesting to note that a very small percentage of costs fall in the Military Construction and Fielding categories. Likewise, R&D accounts for only 5.3% of LCC. The production or investment costs were the remaining element of life cycle cost and averaged 30.6% of the total.

Table 4.2 then provides the data with which one can assess the variance of O&S sub-element costs among each of the 23 weapon systems (Copperhead and SADARM were dropped because they had a negligible amount (1%) of O&S costs).

Military Pay and Allowances accounted for the largest percentage of O&S costs in most of the systems reviewed. The exceptions were the GPS satellite, missiles, SINCGARS and FAADC2I systems. The low military pay costs can largely be attributed to the fact that they don't require unique crews and maintainability is very good so the maintenance personnel requirements are also low. For the remaining systems, manpower and personnel costs accounted for between 25.4% (Apache) and 73.4% (PLS) of total Operating and Support costs. Clearly, the manpower element of O&S costs is a driver which must be estimated very carefully.

TABLE 4.2 DISTRIBUTION OF SUSTAINMENT COSTS BY O&S COST ELEMENT (%)

System	Military Pay & All.			MPA	POL	REPL	AMMO	MOD	SPARE	DEPOT	PCS	OTHER
	CREW	MAINT,	SUPPT	TOT		TRNG			PARTS	MAINT	TRNG	
LOS-F-H	11.4	3.7	22.0	37.1	1.5	0.7	-	1.1	19.7	28.8	3.9	7.2
LOS-R	50.9	0.6	12.8	64.3	0.4	4.7	0.1	1.3	8.7	8.7	6.3	5.5
NLOS	16.1	15.8	18.3	50.2	-	1.9	0.6	1.6	6.0	16.8	6.9	16.0
Patriot	11.6	8.6	9.8	30.0	2.1	2.5	-	6.3	11.0	28.3	4.1	15.7
Stinger	45.2	-	18.6	63.8	0.8	7.3	0.5	0.4	0.3	0.6	10.9	16.4
AHIP	25.9	20.1	18.0	64.0	0.9	5.6	3.0	6.3	5.1	2.1	9.1	3.9
APACHE	6.7	7.9	10.8	25.4	1.2	3.5	13.7	13.9	16.3	9.3	9.1	7.6
Blackhawk	13.3	11.7	12.9	37.9	2.2	4.9	1.6	5.1	15.1	11.7	6.5	15.0
Chinook	16.1	11.3	12.7	40.1	5.9	1.6	-	3.6	6.1	21.2	8.1	13.4
LHX	10.0	8.5	16.8	35.3	3.1	2.0	10.4	4.8	2.8	21.1	9.2	11.3
FMTV	23.1	33.3	-	56.4	5.1	3.3	-	0.4	22.2	2.8	7.4	2.4
PLS	52.3	21.1	-	73.4	2.4	4.2	-	0.4	7.1	0.6	9.8	2.1
MSE	33.1	2.7	27.6	63.4	0.9	1.7	-	0.7	8.9	6.9	13.4	4.1
FAAD2I	-	-	0.2	0.2	1.8	2.9	-	-	59.3	22.2	4.1	9.5
SINCGARS	-	2.3	0.3	2.6	-	0.2	-	1.6	84.8	3.9	0.5	6.4
GPS	-	0.5	7.2	7.7	-	2.3	-	6.6	22.9	7.1	3.8	49.7
AAWS-H	47.9	0.6	5.0	53.5	0.5	0.6	1.7	3.7	3.3	9.9	10.8	16.0
AAWS-M	72.4	2.1	1.7	76.2	-	2.0	-	0.2	3.0	5.5	6.9	6.2
Hellfire	-	-	2.2	2.2	-	-	-	4.1	4.0	63.6	-	26.1
MLRS	7.3	2.1	39.3	48.7	1.6	2.4	-	1.7	12.4	14.7	5.7	12.8
TACMS	-	1.3	3.0	4.3	-	-	-	-	10.7	31.1	-	53.9
TOW	48.1	1.7	8.8	58.6	-	0.7	3.9	9.3	3.3	2.9	4.3	17.0
JSTARS	22.2	9.6	1.9	33.7	1.5	2.6	-	-	20.3	15.6	7.3	19.0

In Chapter 2, each of the O&S cost elements were fully explained. As you recall, eleven broad categories of expenses were presented with each of their subelements. The military personnel pay and allowances which was discussed above and the remaining elements are summarized in Table 4.2 for each of the 23 weapon systems. Two of the elements, Field Maintenance Civilian Labor (5.05) and Transportation (5.06) were not large enough to warrant a separate entry and where they did exist were placed in the Other Sustainment category.

A thorough statistical analysis of the data in this table is really not required. A casual inspection clearly indicates that spare parts, depot maintenance, PCS/training and military pay and allowances appear to capture the majority of O&S costs. POL, replacement training, ammunition/missiles and modifications do not uniformly capture as large of a percentage of O&S costs. The following sections will analyze these data by each commodity group.

COMMODITY AREA ASSESSMENTS

The remaining part of this chapter will focus on a review of O&S costs for each of the major commodity areas. In each case, the analysis will assess the percentage of LCC which are captured in the four elements of sustainment that appear to be the big drivers -- military pay, spare parts, depot maintenance and PCS/Training. As mentioned earlier, R&D and production costs are well known early in the life cycle and sophisticated modeling is really not needed to estimate these costs. Therefore, if a majority of LCC can be captured in these four elements of O&S cost plus R&D and Production, then LCC modeling may only want to concentrate in these areas.

Air Defense

For the 5 systems selected in the Air Defense category, sustainment costs varied between 53% and 77% of total LCC. Within sustainment costs, Military Pay, Spares, Depot Maintenance and PCS/Training (hereafter abbreviated MSDP) accounted for between 73.4% and 89.5% of the total sustainment costs. Thus, if we had a model that was robust in its ability to estimate the MSDP elements and we combine these costs with the system R&D and production costs (which are usually well known) then we find that we've fairly accurately captured between 83.9% and 93.2% of the total LCC for the five systems studied in the Air Defense category.

Aviation

Five helicopter systems were evaluated in the aviation category. Their sustainment costs varied between 45% and 67% of total LCC. Note that the low estimate of 45% is for the LHX program which is in early development and had a specific design goal to reduce O&S costs. Within the sustainment category, if we again focus our attention on the MSDP elements, the BCE's indicate that between 60.1% and 80.3% of sustainment costs are captured in these four elements. When this is combined with R&D and Production costs, the total reflects between 75.1% and 86.8% of total LCC. The 75.1% lower bound is the LCC for the Apache system which is significantly influenced by the large amount of sustainment dollars going into ammunition/missiles and modifications. These two elements accounted for 27.6% of sustainment costs and would have raised the LCC estimate to 91.7% if they were included. The Apache was the only system where the BCE estimated a significant amount of cost in the modification category. However, in ammunition/missiles both the LHX and Apache had significant costs forecast in this area. Consequently, an aviation LCC may want to include ammo/missiles as a adjunct to the MSDP elements in order to capture a minimum of 80% of total LCC.

Automotive

Only two systems, FMTV and PLS, were reviewed in this area. However, the FMTV is a family of trucks which will eventually replace the Army's inventory of medium trucks. The BCEs for these systems indicated that sustainment would account for 75% to 80% of their LCC. Within the sustainment category, the MSDP elements would represent between 88.8% and 90.9% of the total sustainment costs. Consequently, when these are combined with the R&D and Production costs, we find that we've captured between 89.4% and 91.2% of total LCC.

Communications/Electronics

A variety of systems in the C/E arena were reviewed to include the MSE, FAADC2I, JSTARS and the SINCGARS radio. Sustainment costs for these systems ranged from 44% to 79% of total LCC. The notable exception was SINCGARS (44%) which had a maintenance concept which focused on repair by replacement of the end item in the field. This substantially increased its production cost as well as explains why the majority of its O&S costs fall in the spares category. SINCGARS is a good example where the Army has traded off stockage in order to minimize the amount of support manpower required in the field.

Within the sustainment category, the MSDP elements represent between 76.9% and 92.6% of the costs. Consequently, when R&D and Production costs are included, we again find that we've captured between 84.4% and 94.2% of total LCC.

Satellites

In recent years, the Army Space Program has been receiving much attention because of the great potential it holds for the battlefield. The Global Positioning System (GPS) and the Army's Satellite Communications Program are only two examples of the many efforts in this area. As Table 3.1 indicated, a large percentage of life cycle costs for these systems are found in the R&D and production categories. While only 16% of the LCC for GPS were in the sustainment category, it is interesting to note that the MSDP elements accounted for 41.5% of sustainment costs. When this was combined with the R&D and Production costs a total of 83.6% of LCC were still accounted for. Nevertheless, the satellite program obviously is a unique part of the materiel acquisition business and will require special attention in developing acquisition and support strategies.

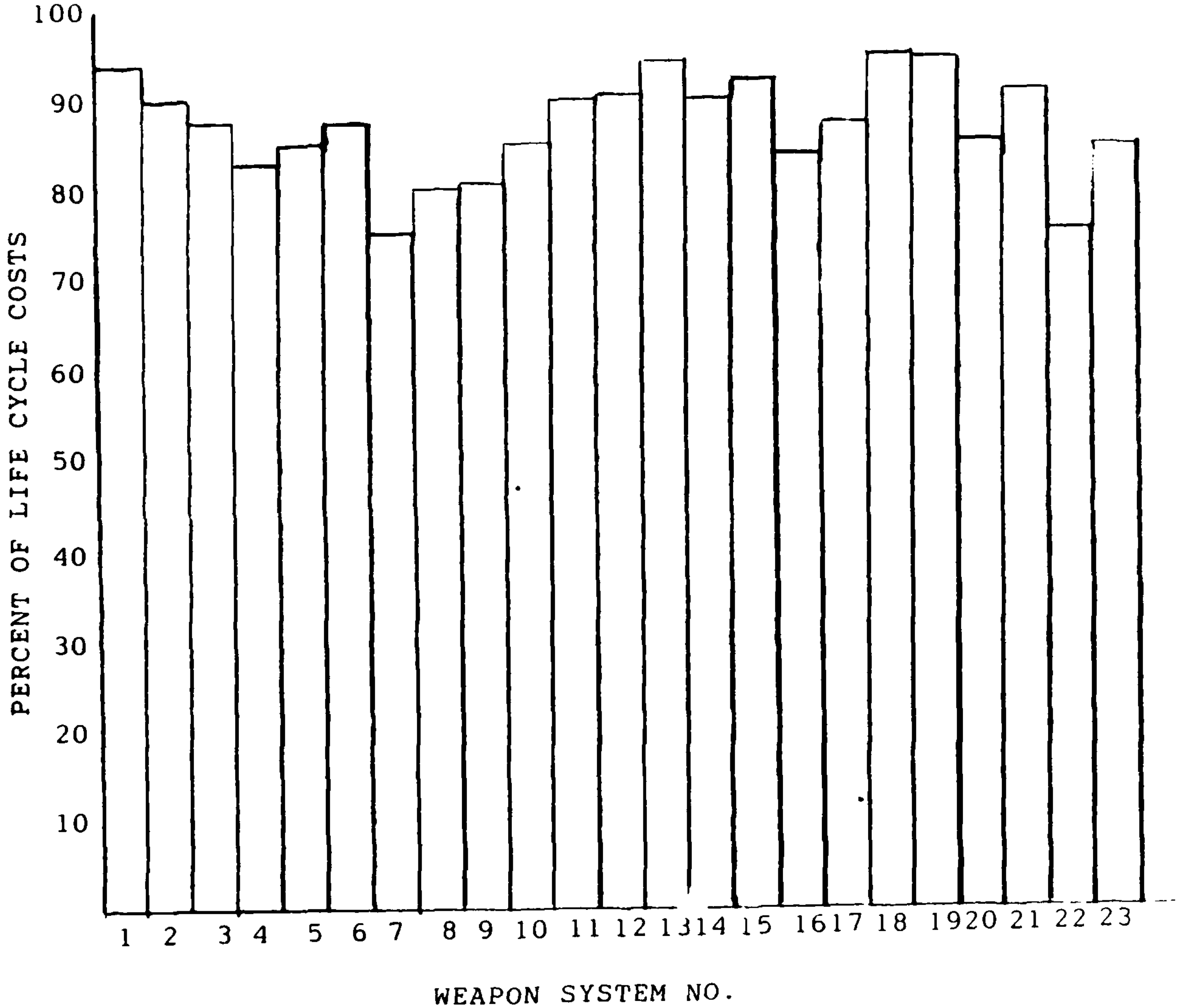
Fire Support

Six systems were reviewed which can generally be classified in the fire support area. As noted, sustainment costs varied from 13% to 80% of LCC. The large disparity was caused chiefly by the inclusion of the Hellfire and TACMS missile systems in which sustainability accounted for only 19% and 13% of their LCC respectively. This is because most of their cost is centered in R&D and investment. Also, there's little maintenance over their life cycle and no dedicated personnel.

Reviewing the contribution that the MSDP elements make to total sustainment cost, it was found that it varied from 46.1% (TACMS) to 91.3% (AAWS-M). However, when we included the MSDP elements with R&D and Production costs, we find that we've captured between 75.3% (TOW) and 94.7% (AAWS-M) of LCC. The TOW system came in somewhat lower than expected mainly because the BCE estimates that 9.3% of its LCC will be required for system modifications and another 17% fall in the "Other" category.

SUMMARY

Figure 4.1 summarizes the analysis presented in this



Weapon System Code

1	LOS-F-H
2	LOS-R
3	NLOS
4	Patriot
5	Stinger
6	AFIP
7	APACHE
8	Blackhawk
9	Chinook
10	LHX
11	FMTV
12	PLS
13	MSE
14	FAADC2I
15	SINCGARS
16	GPS
17	AAWS-H
18	AAWS-M
19	Hellfire
20	MLRS
21	TACMS
22	TOW
23	JSTARS

Figure 4.1 Contribution of Military Pay, Spares, Depot Maintenance, R&D and Production to Total Life Cycle Costs

section. It's quite clear that the four elements of O&S which were reviewed -- military pay, depot maintenance, spares and PCS/Training, drive total O&S cost. This is apparent across all commodity groups reviewed. Additionally, when added to the costs associated with R&D and Production, it is found that in most cases a minimum of 80% of life cycle costs are captured and, in some cases, as high as 94% of LCC are identified.

These four elements are assessed individually largely because of definitions in the cost analysis community. However, when we look at these elements from a logistics perspective, they can really be viewed as two areas. First, military pay, PCS and Training are all costs which fall in the general area of manpower. On the other hand, spares and depot maintenance are directly linked to the maintenance support concept. Consequently, if the Army focuses its attention early in the materiel acquisition cycle on manpower and maintenance concepts, it will almost guarantee that it is minimizing a large portion of the weapon system's O&S cost. Taken together with smart contracting which yields the lowest production costs, this will go on to yield the most favorable LCC the Army can hope to achieve.

A supporting argument to this line of reasoning was provided by Norman Augustine in an article he published in 1978. Mr. Augustine is a former Under Secretary of the Army and is currently the CEO at Martin Marietta. His article addressed life cycle costing and the Service's inability to do a very good job at estimating these costs. He asserted that perhaps it was better that we have not invested large sums of money in developing

LCC models and data collection systems because perhaps they're really not needed.[21]

Most Army systems have normally assumed that an average system's life is 20 years or longer. Obviously, the longer the assumed life of the item, the more O&S will contribute to total life cycle costs, since R&D and production costs remain constant. However, O&S costs represent future expenditures and in the context of R&D and Production dollars, these expenditures can be quite distant in the future. The time value of money has always been recognized by the Army and guidance has directed that economic analyses should apply a 10 percent discount rate when evaluating future costs.

Discounting is the means by which we can evaluate recurring or future expenditures by calculating their value in terms of the value of a dollar in a base year. Usually, analyses consider the base year to be the current or present year. Hence, the concept is frequently referred to as "present value." For example, if the O&S costs for a particular system are expected to be $10 million per year for the next 10 years, the total dollar outlay would be $100 million. However, the value of $10 million in year 10 is much different than the $10 million which would be spent in year 1. Consequently, we must apply a discount rate to each year's outlay to determine the overall present value associated with our hypothetical system's O&S cost. The discount rate accounts for such things as inflation, obsolescence and other factors which influence the value of money and its relative purchasing power. As mentioned above, the Army guidance in economic analysis directs that a 10 percent discount rate be used in Army studies. Thus, in our example, the $10 million in year 10 actually has a present value of $3.86 million. Likewise, year 9 would be $4.24, year 8 would be $4.66, etc. When these are summed, the total present value of a recurring $10 million per year expenditure over 10 years would be $61.45 million -- substantially lower than the $100 million estimate one would get by simply multiplying 10 years times $10 million per year.

The magnitude of the discount rate used in government studies has long been debated. The pros and cons are well beyond the scope of this paper, so lets suffice it to say that some level of discount is appropriate because savings could be used to retire the federal debt and save interest expenditures. Therefore, savings today have much greater value than savings in ten or twenty years.

Mr. Augustine's article provides numerous data which show the impact discounting has on the relative importance of procurement and operating and support costs. In the no-discount case, O&S costs typically ranged from 40-75% of the total life cycle costs. However, when the 10 percent discount rate is applied, this range drops to 20-55%. The bottom line is that for most systems, procurement costs now become the largest portion of life cycle costs![22]

This is not to say that the Army and DOD should abandon all efforts in life cycle costing. The fact is that the Army (and other services) should focus on the items that truly drive cost of ownership. First, we saw that procurement costs were a substantial part of LCC when the principles of discounting were applied. This is very fortunate because the data and techniques are available to fully evaluate these costs early in the life cycle. O&S costs, on the other hand, are dominated by the system reliability (which drives the maintenance concept) and manpower requirements. In designing new systems, we must obviously have systems capable of accomplishing their missions with high probability. This will, to a large part, drive their reliability requirement. Beyond this level, the system reliability becomes a cost trade-off evaluation. If the investment in additional reliability will pay for itself in future O&S savings, then these investments should be made. As seen in Table 4.2, manpower costs represent a large percentage of LCC. Manpower requirements should be habitually challenged throughout a system's life cycle. Maintenance and support concepts must be revisited after the system is fielded to ensure that the most efficient and effective means are being supplied to support the weapon system.

As Norm Augustine aptly concludes in his article :

> "It may be however, that more attention to good sound design practice in the form of enhancing reliability, coupled with efforts to minimize the number of people required to support our systems may offer a more achievable and tangible benefit than increased efforts to calculate life cycle costs. This deserves greater attention than it is afforded in most life cycle cost analyses. And as a minimum, we have an obligation to see that our fighting men go into combat with hardware which does not cost lives even if it does not optimize life cycle costs."[23]

ENDNOTES

19. MG Joe Rigby, HQ AMC, Letter to USAMSAA, 3 October 1989.

20. U.S. Army Materiel Command, Operating and Support Cost Reduction Working Group, Memorandum for Record, AMCRM-E, 10 October 1989. Data are based on Baseline Cost Estimates which were current as of this date. Several BCEs are now under revision.

21. Norman R. Augustine, "Is Life Cycle Cost Costing Lives," *Armed Forces Journal*, January 1978, p. 32.

22. *Ibid*., p. 34.

23. *Ibid*., p. 35.

CHAPTER V

REVIEW OF ARMY MODELS

The cost analysis community uses a variety of methodologies in deriving estimates of life cycle costs. Techniques range from expert opinion to industrial engineering methods to the use of cost estimating relationships (CERs) and other more advanced parametric techniques. As mentioned earlier, the method employed is generally influenced by the stage of the materiel acquisition process that the weapon system is in. Early in the process when data are not generally available, the cost analyst usually has no other option than to use parametric techniques developed for similar systems. As the system matures and proceeds through the development cycle, more data become available, particularly engineering type of data. This then permits more detailed analytical and accounting models to be employed to develop and refine earlier analyses.

Two models have been selected for review. The Logistics Analysis Model (LOGAM) was developed in the late 1960's and is largely an accounting type of model. The Optimum Supply and Maintenance Model (OSAMM) is an analytical model which is used to develop optimum supply and maintenance costs. As such, it is not a true life cycle cost model; however, it tends to capture many of the driving O&S cost elements. Additionally, data requirements are such that it can be used early in the life cycle and thus, becomes a very powerful tool for challenging maintenance concepts early in the materiel acquisition process.

LOGISTICS ANALYSIS MODEL (LOGAM)

The LOGAM model has been in use for many years at the U.S. Army Missile Command. It is a deterministic model which essentially has two modes of operation. First, it can be used to evaluate alternative maintenance concepts on an LRU (Line Replaceable Unit) basis. In its other mode, it evaluates operation and support on a life cycle basis. In this mode, the model focuses on a single TOE (Table of Organization and Equipment) organization and a single theater of operations. Output can be formatted as specified in DA PAM 11-4. Maintenance and operational costs are both combined to yield life cycle O&S costs.[24]

The LOGAM model attempts to capture all O&S costs. It considers not only the basic materiel system but also its support equipment and support organization. Table 5.1 identifies the categories of O&S cost which are estimated by the LOGAM model. The most detailed input data required for the model is at the LRU level. Data requirements include: LRU/Module cost, removal rates, mean time to repair, test and repair times, physical LRU characteristics and modification work orders. A total of 325 input values are needed to run LOGAM. However, 124 are common input parameters which usually only need updating once a year.

It's important to note that LOGAM will not generate a maintenance concept but evaluates the costs of a recommended

TABLE 5.1 COVERAGE OF O&S COSTS IN LOGAM

Military Personnel
- -Crew P&A
- -Maintenance P&A
- -Indirect P&A
- -PCS

Consumption
- -Replenishment Spares
- -POL
- -Unit Training Ammo/Missiles

Depot Maintenance
- -Labor
- -Materiel
- -Transportation

Modifications Materiel

Other Direct Support Operations
- -Maintenance, Civilian Labor
- -Other Direct

Indirect Support Operations
- -Replacement Personnel
- -Transients, Patients, Prisoners
- -Quarters Maintenance/Utilities
- -Medical Support
- -Other Indirect

concept. Therefore, the application of the model becomes an iterative process as the eventual concept becomes more and more refined.

There are a number of logistics support functions which can be evaluated by LOGAM. For example, it can compute:

- o Pipeline costs for spares;
- o Transportation costs;
- o TOE personnel and equipment costs;
- o Operations, maintenance and support manpower costs;
- o Replenishment spares costs;
- o Repair vs Throwaway maintenance costs.[25]

LOGAM has the ability to model as many as 20 maintenance policies in supporting a system. It's output will provide life cycle operation and maintenance costs for a specific unit in a particular theater. One of the model's strengths is that it is very flexible for doing sensitivity analyses. The model can permit several input variables to be varied simultaneously and the results then compared.

LOGAM Limitations

Some of the shortcomings of the LOGAM model are:

o The model requires that a maintenance concept be provided as input. There are no optimization routines included in the model which permit maintenance concepts to be developed by the model on either a cost or availability basis.

o The sparing policy entered into the model may not be optimum nor will the model generate an optimum spares list.

Consequently, LOGAM does not reflect current Army thinking on sparing-to-availability; that is, initial spares being selected to achieve a desired availability target at least cost.

o Shop replaceable units (SRUs) are modeled on an average basis as opposed to treating them individually. Consequently, the model would be unable to make trade-offs at the SRU level.

LOGAM Strengths

Some of the advantages of LOGAM are:

o It computes a large portion of total O&S costs and provides output which is compatible with the format specified in DA PAM 11-4.

o LOGAM has the capability to model an entire system in one run. Some models require significant amounts of computer memory and thus must be modeled a component or subsystem at a time.

o Geographic differences can be recognized and modeled accordingly.

o Initial deployment of end items can be phased over time.

o LOGAM can handle many types of sensitivity analyses on a variety of its basic input parameters.

OPTIMUM SUPPLY AND MAINTENANCE MODEL (OSAMM)

The OSAMM model was included in my research not because it is a true life cycle cost model (which it isn't) but because it has been proven to be a very valuable model for evaluating and deriving support concepts throughout the life cycle. While it does not cover all of the cost elements found in DA PAM 11-4, it does include costs for those items which typically drive O&S cost.

As its name implies, OSAMM is an optimization model. As such, it can either generate an optimum maintenance concept or alternatively evaluate the merits of a given concept. The measures of effectiveness are cost and operational availability. That is, the model will achieve the desired target operational availability at least cost.

The OSAMM model has been jointly developed by the U.S. Army Materiel Systems Analysis Activity and the U.S. Army Communications Electronics Command. It has been applied in most of the major communication/electronic systems in recent years (e.g., SINCGARS and MSE). It can evaluate three levels of indenture (components, modules, and piece parts) and four echelons of repair (organizational, direct support, general support and depot). Test equipment and repair skills are modeled to reflect whether they are commonly shared with other systems or uniquely required to support the system under evaluation.

A total of 66 inputs are required to the model and include such items as: equipment breakdown structure, logistics structure, reliability and maintainability data, inventory cost parameters, order-ship times, turnaround times and operational availability target. Outputs from the model provide: repair level decisions, spares requirements, test equipment and repairman requirements and locations , and cost and operational availability.

OSAMM Strengths

The advantages of OSAMM are:

o It is a true multi-echelon optimization model. Thus, both supply and maintenance concepts are developed at least cost to meet the operational availability targets.

o OSAMM incorporates current Army guidance on sparing-to-availability.

o It considers test equipment and repair skills that are unique to a specific weapon system.

o It can handle up to four echelons of maintenance and three indentures within the system.

o OSAMM is available on a time-sharing computer system which is accessible to both government and contractor personnel. Configuration control is managed by one source so no unauthorized modifications to the model can be made.

o For recurring costs, present value results can be evaluated.

OSAMM Limitations

The primary disadvantage of OSAMM is that it does not compute all relevant life cycle costs nor does it output costs in either DA PAM 11-4 or DCA PAM 92 format. Other limitations include:

o It only considers worldwide support and therefore will not recognize geographic differences.

o There is no time phasing on initial deployment.

o Large systems are difficult to model in one run. Frequently, systems must be modeled at the subsystem level and then combined.

o OSAMM does not address training or indirect manpower costs. If significant amounts of manpower are required between options, then these costs must be assessed off-line.

ENDNOTES

24. Raymon S. Dotson and Ernest C. Seaberg, LOGAM Executive Summary, p. 1.

25. Ibid.

CHAPTER VI

FACTORS IMPACTING O&S COST ANALYSIS IN THE ARMY

The first five chapters of this report have provided the background and analysis of many key aspects of operations and support cost analysis in the Army. Chapter 1 established that indeed O&S costs are a large part of the Army's budget. Chapter 2 provided the details of how O&S costs are categorized and evaluated at the weapon system level of detail. Moving into Chapter 3, it was determined that the basic estimates provided by the cost analysis community (BCE and IPCE) only have a very indirect impact on the Army budgeting process. In Chapter 4, an analysis was presented which confirmed that O&S costs are concentrated in the areas of Military Pay, Depot Maintenance, Spares and Training/PCS. When combined with R&D and Production costs, it was determined that 80% of life cycle costs would be captured for the majority of weapon systems. This analysis confirmed that during the materiel acquisition process, the Army's efforts to reduce O&S costs should be focused on system reliability trade-offs, manpower requirements and maintenance concepts. Chapter 5 reviewed two prominent O&S models which are currently used in the Army. The OSAMM model, while it's not a LCC model, does provide the basis for analyzing maintenance concepts, manpower authorizations and spares stockage policies. The LOGAM model is an accounting model which attempts to capture all of the pertinent life cycle costs. While both of these models have their unique advantages and disadvantages, it is clear that the Army must make frequent use of these tools early in the acquisition process if it hopes to have any influence on life cycle O&S costs.

Consequently, this research has begun to establish a basis for O&S cost considerations in the materiel acquisition process. That is, focus on the elements that drive O&S cost and use standardized analytical models to evaluate tradeoffs in design and support structures. However, there are other factors to consider. The Program Manager still controls many key decisions in the materiel acquisition process. This chapter will look at the PM and what incentives exist to encourage him to evaluate O&S costs. Additionally, reliability vs system cost becomes a very key factor early in the design process. Results of some recent studies in this area will be presented later in this chapter.

Another critical aspect of O&S cost analysis is the availability of credible input data. A short discussion will be provided on the Army's efforts in this area. Finally, the chapter will conclude with a discussion on what is probably the most important point of the materiel acquisition process --Milestone IV, the Logistics Readiness and Support Review. It is at this point that the Army leadership can get a final look at a weapon system before fielding is completed -- i.e., the last chance to make major changes in the system's support structure. An argument will be presented that the Army has not fully utilized this Milestone and therefore has not taken advantage of many potential O&S cost savings.

THE PROGRAM MANAGER

Most of the DOD directives state that total LCC must be a major consideration in system acquisition. However, experience has shown that program managers tend to be more influenced by low procurement costs as opposed to the longer term benefits of lower operating and support costs.

In order to gain some insight into this problem, a study was conducted which consulted over 200 managers in DOD, Congress and Industry. The main hypothesis of the study was that PM's are not likely to optimize life cycle costs if it means increased research and development funds. This was believed to be the case because:

o PMs are allocated R&D dollars and their performance is judged by their staying within allocations;

o Life cycle cost models are not commonly used by the PM offices to assess design trade-offs;

o PMs are not really challenged if they fail to take opportunities to reduce LCC;

o No clear criteria exist whereby R&D investments are made if analysis indicates substantial savings can be realized.[26]

Over 75% of the respondents to this study felt that unit production cost is more important to the PM than life cycle costs. A large percentage also felt that no criteria exists to guide project managers in making decisions regarding life cycle cost savings (over 76% of PM's and 81% of industry respondents disagreed that a clear criteria exists). Probably most surprising was the savings-to-investment ratios which would cause one to proceed with an R&D investment. It was found that 66% of PMs would have to realize at least a 10:1 ratio before making such an investment. However, Congressional and DOD managers agreed 100% that they would invest in a 10:1 return. When asked if analytical tools existed to examine LCC, only 35 percent felt that such tools were available at the PM level.[27]

For most weapon systems, it can easily be demonstrated that life cycle costs are committed very early in the system's development. By the time a system is approved to enter Full Scale Engineering Development, most of the design decisions have been committed and logistics support concepts have been derived as a direct result of these design choices. Consequently, the Army's efforts to reduce O&S costs on fielded systems are going to be much more difficult than reducing support costs on systems that have not yet reached Milestone II. Consequently, the PM is a key player in minimizing O&S costs for new weapon systems. He must fully employ all of the modeling and evaluation techniques available to him which allow trade-offs to be considered between design and long term savings in support costs. One of these critical design decisions is determining what system reliability is best for the Army.

SYSTEM RELIABILITY VS COST

A weapon system's overall reliability is generally one of the items specified in its requirements document. The term used frequently to express this requirement is the Mean Time Between (Mission) Failure or MTBF. The inverse of the MTBF (1/MTBF) is equal to the system's failure rate, i.e., the expected number of failures over some period of usage. If there is no redundancy built into the system, the system's failure rate (F) equals the sum of the failure rates of all components. In mathematical terms,

$$F = \sum_{i=1}^{n} F_i ,$$

where the system has n components.

The weapon system designer will frequently have many trade-offs when determining what components to select for his final system design. For example, component 1 may have three different manufacturers and component reliabilities may differ substantially because of different technologies. All perform equally, however, fail at different rates (and obviously have different costs as well). Thus, the designer may choose the component with the higher failure rate because he knows the remaining system components all have great reliability and he knows he can still meet the overall system requirements. Alternatively, he may have poor reliability in the rest of the system and choose the higher reliability in an effort to bring his system up to the specified need. Obviously, there are different costs depending on which route the designer chooses. In the first case, he may choose the lesser reliability because he has achieved the system goal and can therefore save money and keep his system's final cost to the Army competitive with other manufacturers. But what is best for the Army? The final analysis must not only consider the acquisition cost of the system, but also the life cycle cost. The Army may well benefit from spending more for the initial system, if the cost can be recovered by spending less in operations and support.

The question then becomes how does the government direct the designer of this weapon system to apportion the system reliability at the component level so as to yield the least life cycle costs. A study was completed by the U.S. Army Materiel Systems Analysis Activity (AMSAA) in July 1987 that answered many of these questions. A case study of a newly fielded system was used as the basis for the analysis. Two methods were used to allocate the failure rates. In the first case, F was distributed in an exact proportion of each component's unit price to the total sum of all components cost. Thus, if component i cost $10 and the sum of all components costs was $100, then i would be allocated 10% of the system's failures. The second method was to essentially reverse the order derived in the first method. That is, the most expensive component was allocated the number of failures assigned to the cheapest component in method 1. This approach would then create an envelope of very high costs (method 1) and very low costs (method 2). In order to establish a baseline, the study also used field data to apportion the component failure rates based on actual experience. The results of this analysis are presented in Figure 6.1. Note that the LOGAM and OSAMM models described in Chapter 5 were used to evaluate the alternatives and produced very consistent results. However, more importantly, it is noted that there was a wide range of MTBFs in which logistics costs were relatively insensitive to system MTBF. Consequently, it would not pay the Army to invest in higher system reliability because it would never get a return on its investment. As seen in Figure 6.1, MTBFs between 200 and 280 hours had little effect on overall logistics cost. However, the chart also indicates that cost is affected tremendously by how the failure rates are allocated. For example, at a system MTBF of 140 hours, the apportioning of most failures to the cheapest components yields a logistics cost of approximately $10 million, whereas the inverse condition where failures are apportioned proportionately to their unit price, the cost would be $70-75 million.[28]

The study also used systems which were very early in development (e.g., LHX) to show that sufficient data exists to provide insights to the reliability vs cost trade-off. It concluded that the Army should take a hard look at it system reliability requirements. First, the MTBF required to meet mission goals must be identified. Then, variations about that system requirement should be evaluated much the same as was done in Figure 6.1. The Army will then be in a position to evaluate whether it is prudent to trade-off acquisition dollars versus future O&S costs.

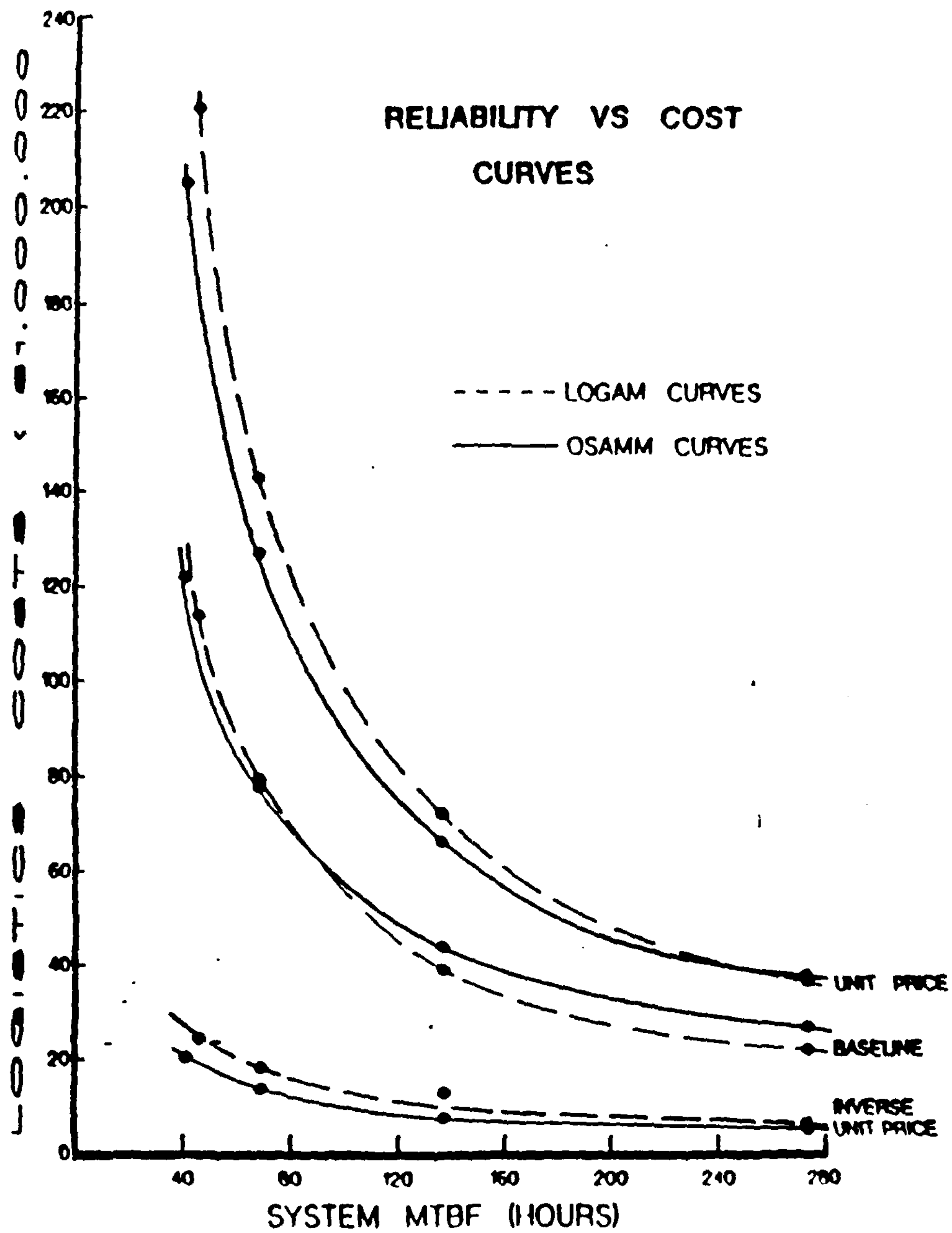


Figure 6.1 System MTBF vs Logistics Cost

OPERATING AND SUPPORT COST DATA BASES

In 1975, the Office of the Secretary of Defense (OSD) directed that the Services develop data bases which would capture historical operating and support costs at the weapon system level. The program was known as the Visibility and Management of Operating and Support Costs (VAMOSC) and has been implemented to a limited extent across most of the Services. The Army's response to this initiative was a system known as the Operating and Support Management Information System (OSMIS). The data elements which are captured in OSMIS are seen in Table 6.1. Currently, there are 17 aircraft systems, 19 combat systems, 2 tactical wheeled vehicles, 2 armament systems, 3 missile systems and 5 electronic systems for which OSMIS collects data.[29]

A significant amount of the effort that has been expended in OSMIS has been in attempts to estimate repair part consumption. The intent of the OSMIS was to collect and report actual data and minimize the use of sample data and estimating. However, OSMIS was constrained in that it was required that no new data bases be created to provide input data. Thus, five existing data bases have been employed in developing repair parts costs:

o <u>Logistics Intelligence File (LIF)</u> is maintained by the Logistics Control Activity of the Army Materiel Command. It contains a record of all Army requisitions from the point in time they are initiated by the user until the materiel is received and posted to the user's inventory.

o <u>Provisioning Master Record (PMR)</u> is maintained by each of

TABLE 6.1 OSMIS DATA ELEMENTS

- Spares (Initial and Replenishment)
- Repair Parts (Initial and Replenishment)
- Fuel Consumption
- Ammunition and Missiles
- Depot Maintenance for Major & Secondary Items
  -- Labor, Materiel, Contracts and Transportation
- Modifications
- Density of End Items
- Activity (Miles/Hours per weapon system per year)

the AMC Major Subordinate Commands. This is a major portion of the Commodity Command Standard System which provides a top-down listing of all parts contained in a weapon system. Early in the system's development, the data contained in the PMR is generally engineering estimates provided in the Logistics System Analysis Record.

o Troop List Extended (TXL) provides geographic and functional information on Army units (Active Army, Army Reserve and Army National Guard);

o Continuing Balance System - Extended (CBS-X) is a classified file which essentially combines the property books of all units in the Army. From this data base, one can determine the densities of all major items of equipment.

o Army Master Data File (AMDF) is maintained by the Catalog Data Activity and is a parts listing of all stock numbers used in the Army. It also provides updated unit prices, weight and interchangeability data for each part.

The above data bases will generate the number of parts consumed, their cost and what units demanded them. The only remaining data element which is required is activity or usage rates for the equipment being supported. These rates are derived from two sources:

o The Army Maintenance Management System - Equipment Data Base for tactical and combat vehicles; and

o Army Aircraft Inventory Status and Flying Times for Army aircraft.

OSMIS then processes the above data to generate parts cost per system per activity rate. Historical files (LIF and CBS-X) are used to the maximum extent possible. When data are not available, the PMR is used to make an engineering estimate of annual parts expenditures. Fuel consumption factors are derived from Sample Data Collection for both Tactical and Combat vehicles as well as aircraft.[30]

Examples of some of the parts costs developed by OSMIS are provided in Table 6.2.[31]

MILESTONE IV - THE KEY O&S DECISION POINT

The acquisition of major systems in the Army is managed within the framework of a very detailed process known as the Life Cycle System Management Model (LCSMM). The LCSMM begins with the determination of the need for the new system and ends when the system is removed from the Army's inventory. The LCSMM is divided into five distinct phases and entry into each phase is managed by a milestone review. The five phases and milestones are as follows:

Milestone 0 -- Concept Exploration/Definition

Milestone 1 -- Concept Demonstration/Validation

Milestone 2 -- Full Scale Development

Milestone 3 -- Full Rate Production/Initial Deployment

Milestone 4 -- Logistics Readiness and Support Review

Milestone 5 -- Major System Upgrade/Replacement Review

TABLE 6.2 COSTS FOR REPLENISHMENT REPAIR PARTS (FY 90 CONSTANT $)[31]

System	Factor	FORSCOM	USAREUR	EUSA	TRADOC	ARNG/USAR	ARMY AVG.
M1	Mile	37.00	35.00	-	48.00	18.00	36.00
M2/M3	Mile	18.00	11.00	-	8.00	5.00	13.00
M60A3	Mile	21.00	15.00	19.00	23.00	17.00	18.00
M113	Mile	4.10	3.90	5.80	4.20	4.10	4.10
M109A3	Mile	22.00	19.00	25.00	23.00	12.00	21.00
M88A1	Mile	14.00	12.00	27.00	13.00	11.00	14.00
M939	Mile	0.45	0.30	0.60	0.80	0.25	0.35
HEMTT	Mile	0.75	0.80	1.25	1.50	0.55	0.80

Milestone 4 is a very critical milestone during the life cycle materiel management process which I contend is not receiving the requisite level of attention it deserves. This phase allows the Army to objectively assess whether many of the support decisions which were made early in the life cycle were correct, and if they weren't, what changes can be made to minimize life cycle costs. Milestone 4 is to be conducted 2 years after the first unit equipped (FUE). Its purpose is to assess "how well operational readiness and support and training objectives are being achieved and maintained."[32] These reviews can be done through System Operational Readiness Reviews or Fielded System Reviews and should include both the Combat and Materiel Developer. While AR 70-1 directs that several areas be reviewed in Milestone 4, there are three items which are critical to life cycle O&S costs. They are:

- o Validity of the support concepts as formulated and tested to date and the ability to perform its mission and meet user requirements (to include reliability and maintainability);
- o Validity of the initial engineering estimates for spare and repair parts;
- o Validity of the Basis of Issue Plan (BOIP) and Qualitative/Quantitative Personnel Requirements Information (QQPRI) data and its effect upon force structure.[33]

Support concepts, component replacement rates and manpower -the three things that we see time and again driving the O&S costs for the Army's major systems. Obviously, the requirements have been placed on the Army to accomplish these reviews and make adjustments so as to reduce the O&S cost burdens associated with operating its major systems. However, it is the opinion of the author that the Army has not critically reviewed these areas. A number of recent studies support my conclusion. First, earlier in this chapter, I presented the results of recent work on the issue of reliability vs cost. Figure 6.1 provided the results of how total logistics cost varied as a function of system reliability. The support concept which was evaluated in Figure 6.1 was exactly as the system was being supported in the field. As part of the study, the team then used the optimization feature of the OSAMM model to determine if logistics costs could be reduced. As seen in Figure 6.2, the logistics costs of the optimum case were well below the current support costs for all MTBFs. For example, for the baseline case, using current component failure rates, it was determined that logistics costs at 160 hours MTBF were almost twice as much when the current maintenance concept was compared to the OSAMM option.[34]

Another AMSAA study that was completed in April 1988 reviewed a large population of Army reparable components to determine if it would be more cost effective to throw the items away rather than repair them. The study found that 78% of the items currently being repaired are candidates for discard and if discarded could result in savings in as much as 25% of total life cycle repair costs.[35] The study concluded that in the future, systems should be routinely analyzed to determine if proper repair policies are being implemented in the field.[36]

Unfortunately for the Army, the emphasis in O&S cost analysis has been placed on collecting data on how equipment is

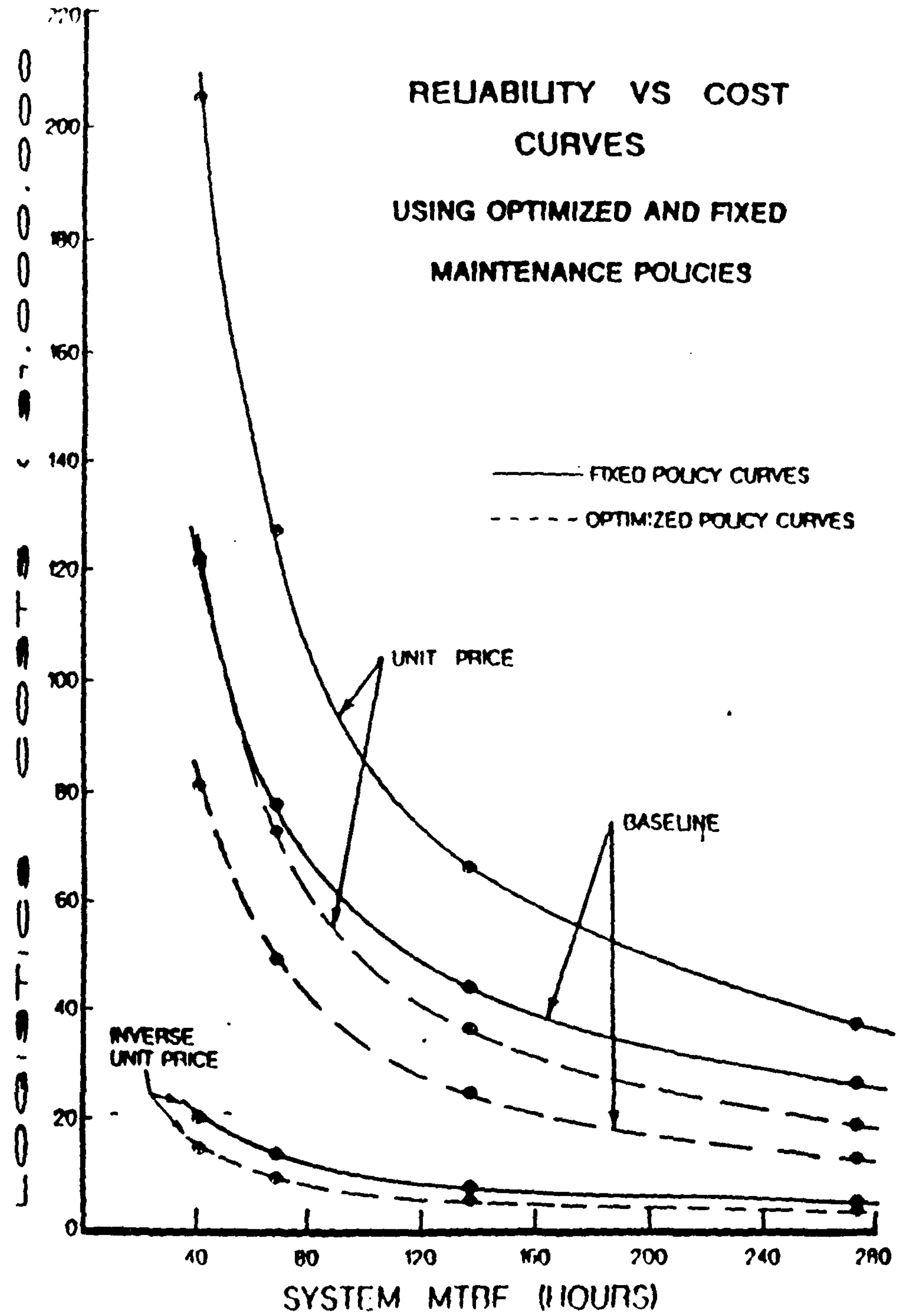


Figure 6.2 OSAMM Optimized Cost vs Reliability

actually supported in the field--so as to justify the O&S expenditures. Little has been done to challenge maintenance concepts on systems once they have been fielded. As seen in the examples presented in this chapter, it appears that the potential O&S cost savings from such reviews are quite significant. Consequently, the areas which probably hold the most potential for O&S savings may well be going unnoticed.

STANDARD LIFE CYCLE COST/LEVEL OF REPAIR ANALYSIS MODEL

In 1978, the Marine Corps recognized that their procedures for life cycle costing were outdated and ineffective. Tracing the sources of individual weapon system cost elements was virtually impossible. Further complicating this situation was the constant turnover of project personnel. Thus, no corporate institutional memory existed which would foster a continual update and refinement of life cycle cost estimates. These problems led the Marine Corps to convene a life cycle cost conference in 1978. The conference was the impetus for the eventual development and implementation of a standard structure for developing life cycle costs. Furthermore, the effort also resulted in a standard life cycle cost model which would be used to refine and develop estimates over time. The model which was developed was based on the Army's TRI-TAC life cycle cost model which was originally developed by the Joint Tactical Communications Office at Fort Monmouth.[37]

There are several factors that support the development of a standard life cycle cost format and model. First, it substantially improves communication among program players. With common definitions of cost elements and a standardized methodology, comparisons can easily be made over time and easily communicated as personnel in key positions change jobs. As with any model that has wide application, a concern existed that potential users may modify the internal logic to meet individual needs and preferences. This problem was overcome by placing configuration control on the source code in the model and maintaining similar control over the "official" data base for each system. The Marine Corps model was placed on a commercial time sharing system so configuration control of the model was easily accomplished. By putting the "official" data base under the control of the Marine Corps Acquisition Coordinating Group, similar control was ensured in maintaining the integrity of the data base. While individual users could establish and use their own data bases, they could not alter the basic data files. Consequently, initial and follow-on estimates would be maintained in a logical file for future reference, thus maintaining a clear audit trail. Another critical advantage of a standard LCC model is that the service can specify that contractors use it in developing their initial cost estimates. This was the case during the development of the Marine Integrated Fire and Air Support System. For the first time, the Marines were able to compare contractor, independent and government life cycle cost estimates, knowing that each was based on a common definition of terms and common methodology.[38]

The Marine Corps experience highlights two serious problems which are encountered in life cycle costing -- completeness and accuracy. Completeness of cost estimates can best be ensured by clearly defining a common cost structure. The accuracy of life cycle cost estimates is clearly a more difficult problem. However, by specifying a common model this was achieved by directing, where possible, that common factors (e.g., system life expectancy, operating tempo, personnel costs) be used and establishing bounds for each of the cost elements. This has led the Marine Corps to a much improved system of life cycle costing that overcomes many of the problems frequently encountered in developing credible estimates.

Some of these problems have been overcome in the Army. DA PAM 11-4 and DCA PAM 92 have gone a long way in developing a standard cost structure. The most critical problem that the Army faces, however, is the lack of one standard model. Each of the AMC major subordinate commands has unique models used at various points in the materiel acquisition cycle. This obviously inhibits communication and comparison of results among systems and sometimes even within the same system. As noted in the Marine Corps experience, substantial benefits could accrue to the Army from adopting a standard model which is used not only in the cost analysis community but also specified in future contracts for contractor use early in the life cycle.

ENDNOTES

26. LTC Troy V. Caver, "Life Cycle Cost: Attitudes and Latitudes," Defense Management Journal, July-August 1979, p. 14.

27. Ibid., pp. 15-16.

28. U.S. Army Materiel Systems Analysis Activity, Life Cycle Cost Versus Reliability Study, pp. 31-37.

29. Calibre Systems Inc., Materiel System Sustainment Factors, pp. II-2 to II-3.

30. Ibid., pp. II-1 to II-29 and III-1 to III-3.

31. Ibid., pp. A-2 to A-3.

32. U.S. Department of the Army, Army Regulation 70-1, p. 14. (Hereafter referred to as "AR 70-1").

33. Ibid.

34. Life Cycle Cost Versus Reliability Study, op cit, p. 41.

35. Donald A. Orr, The APRICOT Analysis, p. 39.

36. Ibid., p. 58.

37. Paul T. McIlvaine, "Ensuring Optimal System Acquisition Through Life Cycle Costing," Defense Management Journal, Fourth Quarter 1981, pp. 35-37.

38. Ibid., pp. 37-39.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Linkage of Baseline Cost Estimates and PPBES

The new instructions for formatting the BCE/ICE have now clearly aligned each O&S cost element with its corresponding appropriation. The problem which remains however, is working backwards from the various appropriations to the weapons systems they support. Unfortunately, not all systems have detailed BCE/ICEs. Consequently, decomposing the total OM&A budget to individual weapon systems becomes extremely difficult, if not impossible. Thus, the Army has been successful in aligning its cost estimating procedures with the PPBES system. However, it still has a significant problem in relating the impact of substantial appropriation cuts on individual weapon systems and even more importantly, the impact that cuts have on the overall readiness of the Army.

Standard Life Cycle Cost Model

There does not exist today in the Army one standard LCC model that is used across all commodity areas. Instead, there are many in use, most of which have substantially different basic methodologies. This results in great difficulties in communicating study results and comparing results among like systems. Additionally, tracking system costs and maintaining a corporate knowledge base on critical system decisions becomes nearly impossible.

O&S Cost Data Bases

Since the early 1970s, the Army has been attempting to develop a management information system which would provide credible O&S cost data and meet with OSD mandates. The efforts to date have resulted in a very complicated set of manual and automated procedures which are constrained (by direction) to using existing data bases. Such an approach is manpower intensive and the quality of data is still very questionable.

Indirect O&S Costs

This report has only focused on one portion of O&S costs in the Army -- that which can be related to our weapon systems. The indirect costs associated with the administration of the Army (i.e., the TDA Army) represents a sizable portion of the Army's budget which is very difficult to relate to its inventory of weapon systems. Nearly one-third of the Army's manpower is found in these TDA organizations. While those in R&D and system acquisition are easily related to weapons systems, others are not. Furthermore, attempts to reduce the O&S costs in these areas is more a function of organizational efficiency vs weapon system design. The development of such measures are beyond the scope of this paper but remain an issue that needs to be addressed in managing the Army's total O&S budget.

RECOMMENDATIONS

O&S Costing in the Army

It is felt that the Army's O&S cost program can best be put on track by pursuing a number of related actions. Consequently, it is recommended that the Army's efforts in O&S costs be concentrated in the following areas:

o Mandatory application of a standard level of repair/life cycle cost analysis at every major milestone, the results of which will be briefed through the PEO structure to the AAE. Such analyses will evaluate both planned support structures as well as "optimum" structures generated by the Level of Repair Analysis (LORA) model. Differences, when they exist, in the two support structures will be fully documented to establish the PM's rationale for pursuing more costly support alternatives.

o The standard LCC/LORA model will focus its cost computations in the areas of Military Pay, Depot Maintenance, Spares and Training/PCS and should compute costs in both constant dollars and present value.

o The standard LCC/LORA model will be included in the acquisition strategy, source selection criteria and fielded systems review. System contracts will specify that contractors will report input values used in preparing their proposals.

o Reliability vs Cost analyses are a critical part of the design process. Such analyses should be completed and presented to Army leadership prior to Milestone II decisions.

o HQDA charter an analytic group with specific responsibilities to review the support concepts of existing fielded equipment. All equipment should be considered which is expected to have a remaining useful life of at least 10 years. This group should use existing analytical tools such as OSAMM to challenge existing support concepts and quantify potential savings which would result from new support alternatives.

O&S Logistics Data Bases

The Army, like many of the other Services, has continued to create new data collection systems. The result has been a morass of data which serves no one well. It was very praiseworthy of the OSMIS effort to specify that no new data bases be created. However, this forced the Army to develop a new MIS which selected those data it could use and fill in the gaps the best it could. The OSMIS effort was an attempt to collect "all" of the data so nothing had to be estimated. Although this appears to be a very thorough approach, it is nevertheless impractical. The Army needs to get its data collection programs in order. There are many of them -- Sample Data Collection, Logistics Support Analysis Records, Field Exercise Data Collection and Central Demand Data Base just to name a few.

The analysis provided in this report indicates that estimating O&S costs can be done reliably if the Army focuses on a few key elements. The same is true in level of repair analyses -- a few key input parameters are needed to do a credible job. Thus, it is recommended that the Army consolidate its data collection efforts and focus it on those data items that are most critically needed. Because this is a big job, I would further recommend that the Army create a PM and resource it to design and implement a logistics data system. The system would be designed to minimize the data collection to only those essential data elements needed for O&S cost analysis, LORA and other required studies. Existing data bases would be phased out as the central data base comes on line and it would provide a common source of data for all logistics evaluations and requirements studies.

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